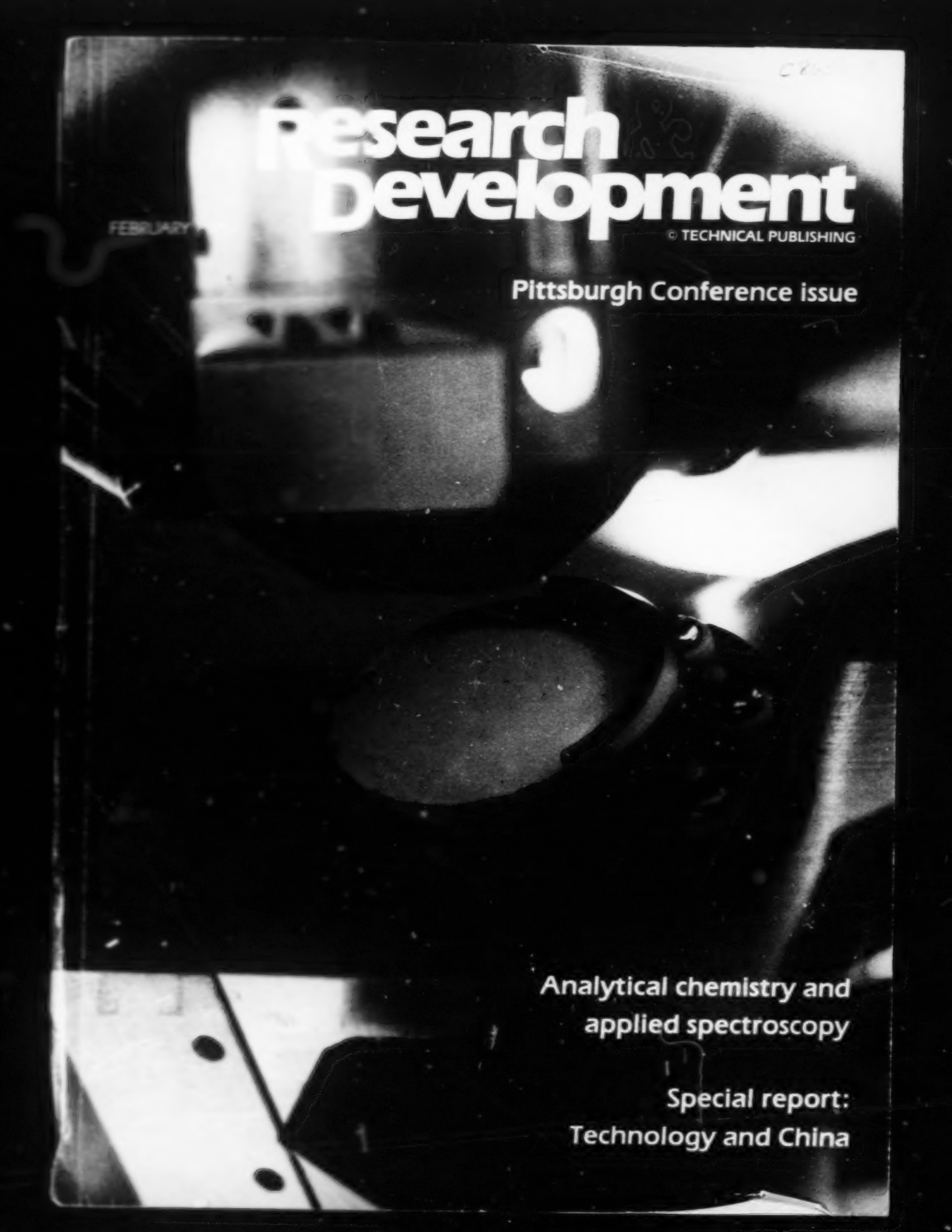
Research Development
FEBRUARY
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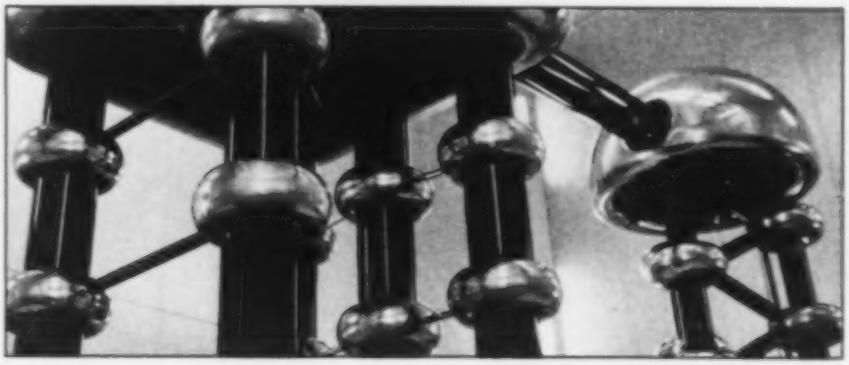
Pittsburgh Conference issue
Analytical chemistry and applied spectroscopy
Special report: Technology and China

Research & Development

SERVING THE $202-BILLION WORLDWIDE R&D INDUSTRY

Pre-accelerator for an energy-saver ring. See p 136.



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ABOUT THE COVER

Recent advances in ESCA instrumentation provide high angular resolution and high count rates at low takeoff angles. These advances permit profiling through thin layers near the surface of a specimen.

Thus, variable-angle ESCA analysis permits probing of atomic layers on surfaces and at grain boundaries and interfaces. The cover picture, from PHI Perkin-Elmer, shows a phosphor being irradiated by an *x*-ray source in an ESCA instrument.

A related article begins on p 144, and another spectroscopy article begins on p 150. Articles on the Pittsburgh Conference and on analytical instrument trends begin on pp 157 and 174.

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Special Report—Technology and China

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136 The superconducting super accelerator: Leon M. Lederman, Fermilab; particle physicists say a bigger ring is needed to expose the building blocks of nature.

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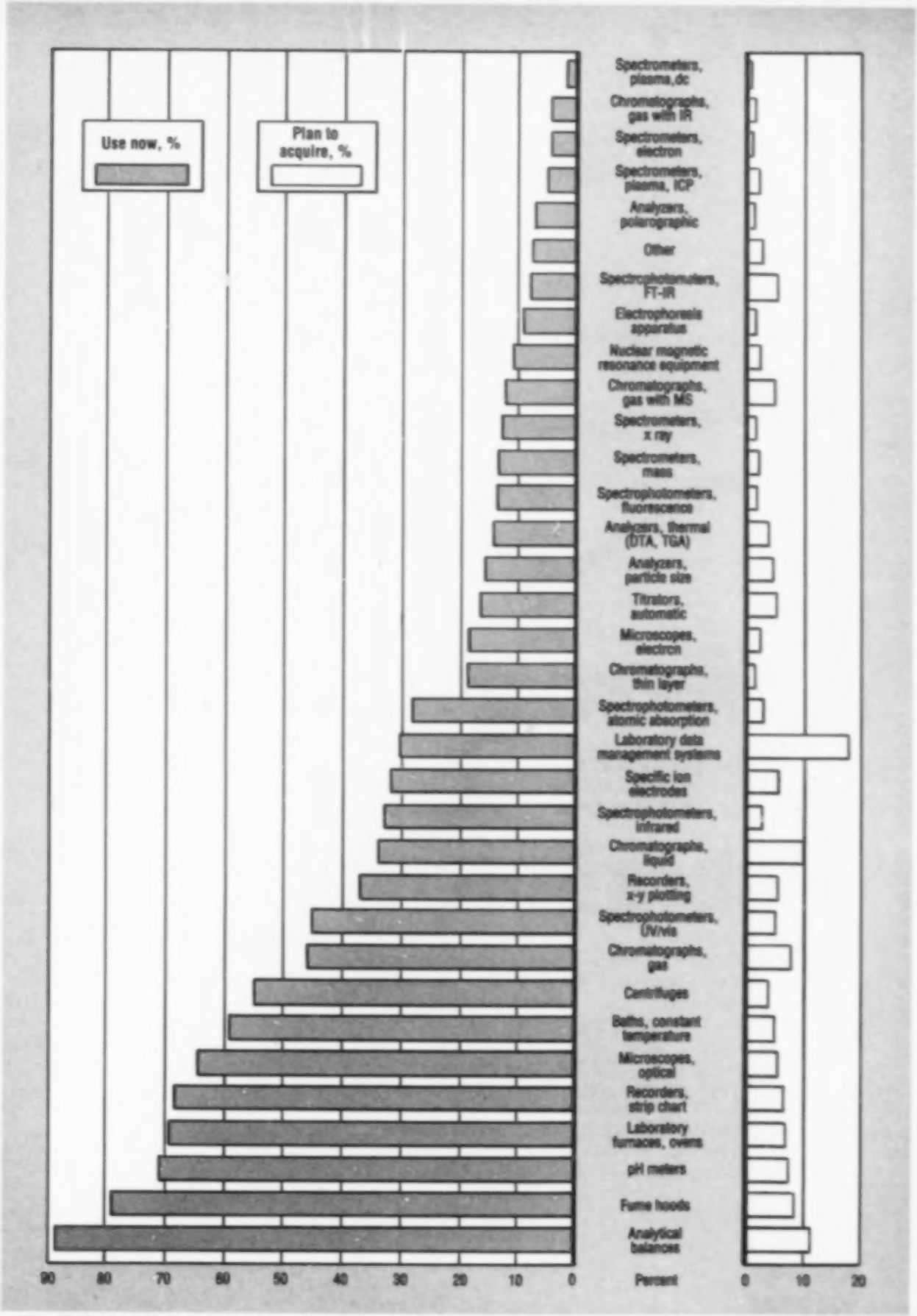

Use now, %
Plan to acquire, %
Spectrometers, plasma, dc
Chromatographs, gas with IR
Spectrometers, electron
Spectrometers, plasma, ICP
Analyzers, polarographic
Other
Spectrophotometers, FT-IR
Electrophoresis apparatus
Nuclear magnetic resonance equipment
Chromatographs, gas with MS
Spectrometers, x ray
Spectrometers, mass
Spectrophotometers, fluorescence
Analyzers, thermal (DTA, TGA)
Analyzers, particle size
Titrators, automatic
Microscopes, electron
Chromatographs, thin layer
Spectrophotometers, atomic absorption
Laboratory data management systems
Specific ion electrodes
Spectrophotometers, infrared
Chromatographs, liquid
Recorders, x-y plotting
Spectrophotometers, UV/vis
Chromatographs, gas
Centrifuges
Baths, constant temperature
Microscopes, optical
Recorders, strip chart
Laboratory furnaces, ovens
pH meters
Fume hoods
Analytical balances
90
80
70
60
50
40
30
20
10
0
Percent
0
10
20

C.J. Mosbacher
Executive editor, *R&D*

TRENDSURVEY

Use of analytical instruments and equipment, 1985

Average plans to acquire the 33 types of instruments listed in our annual survey increase more than 3% from last year, even after adjustments for demographics.

NO MATTER how you look at it, scientists and engineers are planning to acquire more analytical instruments and equipment in 1985 than they did in 1984. Yes, our latest annual Trendsurvey shows decreases in plans to acquire some instrument types, 9 to be exact, but their plans to acquire 20 types increase while plans for 4 types stay the same.

Looked at another way, plans to acquire average 5.13%, up significantly from the 1984 figure of 4.97%. Even after normalization to account for changes in the demographics or respondents, plans to acquire for 1985 actually increase slightly, to 5.14%. Average present use, which was 31.7% last year, drops less than 1.4% to 31.3% before normalization, which is 31.2% after normalizing.

For present use, 12 categories are up, 2 are equal, and 19 are lower than last year. The biggest gain was achieved by gas chromatographs, followed by liquid chromatographs, atomic absorption spectrophotometers, infrared spectrophotometers, laboratory data management systems, and FT-IR spectrophotometers. The biggest loss of present use was for laboratory furnaces and ovens, followed by strip-chart records, optical microscopes, electrophoresis apparatus, and mass spectrometers.

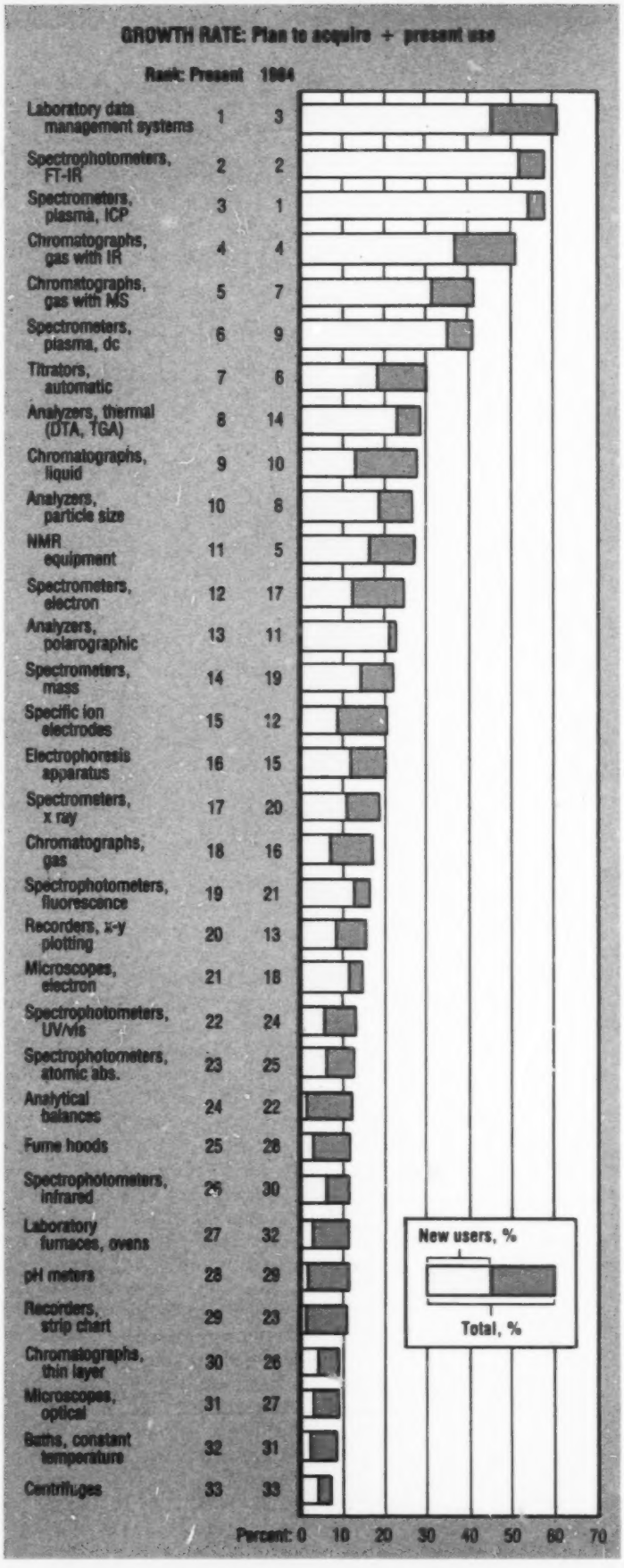
Largest gain of the 20 categories with increased plans to acquire was achieved by 2 categories, GC-MS and liquid chromatographs. Next largest, in order, were laboratory furnaces and ovens, laboratory data management systems, thermal analyzers, and UV/vis spectrophotometers.

The largest loss in plans to acquire was for x-y plotting recorders, followed by strip-chart recorders, optical microscopes, specific ion electrodes, and electron microscopes.

Ranking by present use is shown in the first bar chart for all 33 categories and "other" on a total-sample basis. On that same basis, rankings for plans to acquire are led by laboratory data management systems, followed by analytical balances, liquid chromatographs, fume hoods, and gas chromatographs. Last year, strip-chart recorders occupied third place, and fume hoods were sixth.

Rankings by growth rate (plans to acquire divided by present use for each category) are shown in the second bar chart. Laboratory data management systems rank first on this basis also, although other categories now occupy the remaining top spots. Rankings for last year also are shown on the chart. The differences between using the total sample versus the present use as a base for calculating growth or growth rate are well illustrated by this comparison of rankings.

Gains in these rankings were lead by thermal analyzers, up six places from last year. Laboratory furnaces and ovens and electron spectrometers each are up five places, with infrared spectrophotometers up four places (FT-IR, incidentally, held second place). Biggest loser in the rankings were x-y plotting recorders, which dropped seven places in the rankings, followed by NMR equipment and strip-chart recorders,


GROWTH RATE: Plan to acquire + present use
Rank: Present 1984
Laboratory data management systems 1 3
Spectrophotometers, FT-IR 2 2
Spectrometers, plasma, ICP 3 1
Chromatographs, gas with IR 4 4
Chromatographs, gas with MS 5 7
Spectrometers, plasma, dc 6 9
Titrators, automatic 7 6
Analyzers, thermal (DTA, TGA) 8 14
Chromatographs, liquid 9 10
Analyzers, particle size 10 8
NMR equipment 11 5
Spectrometers, electron 12 17
Analyzers, polarographic 13 11
Spectrometers, mass 14 19
Specific ion electrodes 15 12
Electrophoresis apparatus 16 15
Spectrometers, x ray 17 20
Chromatographs, gas 18 16
Spectrophotometers, fluorescence 19 21
Recorders, x-y plotting 20 13
Microscopes, electron 21 18
Spectrophotometers, UV/vis 22 24
Spectrophotometers, atomic abs. 23 25
Analytical balances 24 22
Fume hoods 25 28
Spectrophotometers, infrared 26 30
Laboratory furnaces, ovens 27 32
pH meters 28 29
Recorders, strip chart 29 23
Chromatographs, thin layer 30 26
Microscopes, optical 31 27
Baths, constant temperature 32 31
Centrifuges 33 33
New users, %
Total, %
Percent: 0 10 20 30 40 50 60 70

each losing six places. Thin-layer chromatographs and optical microscopes each lost four places in these rankings by growth rate.

Before turning to demographics, another indication of the reality of increased plans to acquire is given by changes in the percentages of those not giving any answers for present use and plans to acquire. In the present Trendsurvery, 2.1% did not indicate present use of any instrument, compared to 1.0% last year. Conversely, for plans to acquire, "no" answers dropped to 39.4% from 41.0% in last year's results.

As for demographics, geographic distribution of respondents again parallels the circulation of *R&D*, lending validity to the results because that circulation is kept in proportion to distribution of funds and personnel in the field. New England accounts for 6.9% of respondents to the Trendsurvey, Middle Atlantic 17.8, East North Central 19.5, West North Central 6.2, South Atlantic 14.0, East South Central 4.0, West South Central 7.5, Mountain 4.8, and Pacific 11.9.

By discipline, 20.7% list engineering, 56.9 physical science, 19.6 life science or medicine, while 2.9 gave no answer. For last year's survey, the comparable data were 23.3% engineering, 53.6 physical science, 20.2 life science or medicine, and 2.9 no answer. Thus there has been a shift of 3.3 points, or 7.4%, to the physical sciences from the other categories.

By employer, 59.2% work in industry, 14.1 in universities, 16.0 in government, 3.1 in nonprofit organizations, 2.4 in medical research centers, 4.0 other, and 1.2 no answer. Corresponding data for last year were 57.7% industry, 16.0 universities, 15.5 government, 3.8 nonprofit, 2.3 medical research, 3.3 other, and 1.3 no answer.

By job function, 4.0% are corporate officers, 8.2 R&D executives, 13.6 project managers, 67.2 professional staff, 5.0 other, and 1.8 no answer. This is a shift of almost 6.9% from management to staff positions from last year, when the corresponding figures were 4.2% corporate officers, 7.7 R&D executives, 15.8 project managers, 66.5 professional staff, 4.3 other, and 1.6 no answer.

This Trendsurvey was conducted by including a prepaid business reply card in a mailing to *R&D* readers in the United States in late September 1984. To meet deadlines, only replies received by early November could be included in the data here. R&D

GROWTH RATE (bar chart at left) is calculated with present use as base for each instrument category. Total includes all those who plan to acquire; new users are those who do not presently use that instrument but who plan to acquire. Difference is present users planning to acquire additional or replacement units in that particular instrument category.

PRESENT AND PLANNED USE: Data from 1,261 respondents * = 1984	Use now								Plan to acquire within 1 yr								Growth rate = plan to acquire + by present use				
	Total 1,261		Engineering 261		Physical science 717		Life science or medicine 247		Total 1,261		Engineering 261		Physical science 717		Life science or medicine 247		Total	Present users who plan to acquire		New users	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	%	No.	%	No.	%
Analytical balances	1,129	89.5 *88.4	201	77.0	664	92.6	200	93.1	135	10.7 *10.6	20	7.7	94	13.1	20	8.1	12.0	116	10.3	19	1.7
Analyzers, particle size	206	16.3 *17.9	47	18.0	124	17.3	28	11.3	59	4.7 * 4.8	15	5.7	38	5.3	5	2.0	28.6	19	9.2	40	19.4
Analyzers, polarographic	89	7.1 * 6.0	11	4.2	62	8.6	12	4.9	20	1.6 * 1.4	6	2.3	13	1.8	1	0.4	22.5	1	1.1	19	21.3
Analyzers, thermal (DTA, TGA)	177	14.0 *15.9	42	16.1	115	16.0	15	6.1	53	4.2 * 3.3	9	3.4	39	5.4	3	1.2	29.9	11	6.2	42	23.7
Baths, constant temperature	747	59.2 *61.5	110	42.1	425	59.3	192	77.7	67	5.3 * 5.8	15	5.7	40	5.6	12	4.9	9.0	45	6.0	22	2.9
Centrifuges	692	54.9 *55.1	71	27.2	339	54.3	209	84.6	53	4.2 * 4.4	8	3.1	26	3.6	17	6.9	7.7	27	3.9	26	3.8
Chromatographs, gas	585	46.4 *43.9	69	26.4	408	56.9	87	35.2	108	8.6 * 8.2	9	3.4	81	11.3	16	6.5	18.5	67	11.5	41	7.0
Chromatographs, gas with IR	55	4.4 * 4.9	13	5.0	33	4.6	5	2.0	28	2.2 * 2.0	3	1.1	23	3.2	1	0.4	50.9	7	12.7	21	38.2
Chromatographs, gas with MS	148	11.7 *11.8	13	5.0	114	15.9	15	6.1	62	4.9 * 3.2	3	1.1	43	6.0	12	4.9	41.9	15	10.1	47	31.8
Chromatographs, liquid	429	34.0 *31.6	31	11.9	278	38.8	105	42.5	126	10.0 * 8.3	9	3.4	88	12.3	28	11.3	29.4	71	16.6	55	12.8
Chromatographs, thin layer	244	19.3 *19.7	12	4.6	154	21.5	72	29.1	24	1.9 * 2.1	2	0.8	16	2.2	5	2.0	9.8	14	5.7	10	4.1
Electrophoresis apparatus	124	9.8 *12.5	6	2.3	37	5.2	78	31.6	25	2.0 * 2.4	2	0.8	13	1.8	10	4.0	20.2	9	7.3	16	12.9
Fume hoods	1,000	79.3 *80.2	178	68.2	592	82.6	202	81.8	111	8.8 * 8.2	30	11.5	63	8.8	15	6.1	11.1	78	7.8	33	3.3
Laboratory data mngmt. systems	380	30.1 *28.4	58	22.2	234	32.6	79	32.0	232	18.4 *17.3	47	18.0	141	19.7	38	15.4	61.1	59	15.5	173	45.5
Laboratory furnaces, ovens	881	69.9 *76.2	177	67.8	537	74.9	137	55.5	94	7.5 * 6.1	29	11.1	54	7.5	9	3.6	10.7	67	7.6	27	3.1
Microscopes, electron	239	19.0 *19.7	67	25.7	116	16.2	47	19.0	36	2.9 * 3.6	10	3.8	21	2.9	5	2.0	15.1	10	4.2	26	10.9
Microscopes, optical	818	64.9 *68.0	170	65.1	447	62.3	179	72.5	75	5.9 * 7.0	23	8.8	35	4.9	14	5.7	9.2	48	5.9	27	3.3
Nuclear magnetic resonance eqpmt.	127	10.1 * 9.5	12	4.6	100	13.9	11	4.5	36	2.9 * 2.9	4	1.5	22	3.1	9	3.6	28.3	12	9.4	24	18.9
pH meters	904	71.7 *71.4	127	48.7	527	73.5	221	89.5	97	7.7 * 7.0	18	6.9	59	8.2	16	6.5	10.7	76	8.4	21	2.3
Recorders, strip chart	869	68.9 *72.5	177	67.8	508	70.9	161	65.2	91	7.2 * 8.6	24	9.2	52	7.3	14	5.7	10.5	75	8.6	16	1.8
Recorders, x-y plotting	476	37.7 *37.7	127	48.7	258	36.0	78	31.6	74	5.9 * 7.9	29	11.1	34	4.7	11	4.5	15.5	31	6.5	43	9.0
Specific ion electrodes	400	31.7 *32.0	46	17.6	273	38.1	67	27.1	81	6.4 * 7.3	13	5.0	50	7.0	15	6.1	20.3	44	11.0	37	9.2
Spectrometers, electron	56	4.4 *4.4	15	5.7	31	4.3	9	3.6	15	1.2 * 0.8	4	1.5	9	1.3	2	0.8	26.8	8	14.3	7	12.5
Spectrometers, mass	164	13.0 *15.7	26	10.0	118	16.5	16	6.5	36	2.9 * 2.6	8	3.1	24	3.3	4	1.6	22.0	13	7.9	23	14.0
Spectrometers, plasma, dc	17	1.3 * 2.4	2	0.8	11	1.5	3	1.2	7	0.6 * 0.6	3	1.1	4	0.6	—	—	41.2	1	5.9	6	35.3
Spectrometers, plasma, ICP	61	4.8 * 3.7	11	4.2	45	6.3	3	1.2	36	2.9 * 2.7	2	0.8	28	3.9	2	0.8	59.0	3	4.9	33	54.1
Spectrometers, x ray	153	12.1 *13.6	30	11.5	106	14.8	12	4.9	29	2.3 * 2.1	7	2.7	18	2.5	4	1.6	19.0	10	6.5	19	12.4
Spectrophotometers, atomic abs.	348	27.6 *25.3	40	15.3	247	34.4	51	20.6	43	3.4 * 2.7	6	2.3	33	4.6	3	1.2	12.4	20	5.7	23	6.6
Spectrophotometers, fluorescence	166	13.2 *13.5	16	6.1	86	12.0	39	23.9	30	2.4 * 2.0	3	1.1	15	2.1	12	4.9	18.1	7	4.2	23	13.9
Spectrophotometers, FT-IR	108	8.6 * 7.1	16	6.1	79	11.0	8	3.2	64	5.1 * 4.7	10	3.8	51	7.1	1	0.4	59.3	7	6.5	57	52.8
Spectrophotometers, infrared	424	33.6 *31.5	48	18.4	323	45.0	38	15.4	46	3.6 * 3.1	9	3.4	30	4.2	7	2.8	10.8	21	5.0	25	5.9
Spectrophotometers, UV/vis	571	45.3 *44.5	49	18.8	366	51.0	141	57.1	72	5.7 * 4.9	8	3.1	46	6.4	16	6.5	12.6	39	6.8	33	5.8
Titrators, automatic	221	17.5 *18.0	21	8.0	166	23.2	27	10.9	67	5.3 * 5.3	10	3.8	45	6.3	10	4.0	30.3	24	10.9	43	19.5
Other	98	7.8 * 8.2	23	8.8	54	7.5	19	7.7	44	3.5 * 3.8	9	3.4	26	3.6	7	2.8	44.9	22	22.4	22	22.4